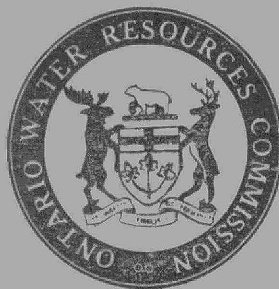


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THE
ONTARIO WATER RESOURCES
COMMISSION



REQUIRED DENSITY
of
WATER QUALITY SAMPLING STATIONS
at
NANTICOKE, LAKE ERIE

August - September, 1968

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REQUIRED DENSITY
OF
WATER QUALITY SAMPLING STATIONS
AT
NANTICOKE, LAKE ERIE

August - Sept., 1968

M. D. Palmer,
Water Quality Surveys Branch
Division of Sanitary Engineering

WQR-1

REQUIRED DENSITY OF WATER QUALITY SAMPLING STATIONS
AT NANTICOKE, LAKE ERIE

ABSTRACT

Three stations approximately two miles apart were sampled at two hour intervals for ten hours. Multiple readings of dissolved oxygen (DO), pH, alkalinity and total phosphates were taken at the mid-depth at each station on each run. As a result of a parametric analysis of variance, two-way classification, fixed effects model with multiple readings per cell, the following was determined:

1. There is a significant difference between stations 5004, 994 and 501 in measured alkalinity and total phosphate values for the test period using existing equipment and sampling techniques.
2. There is a significant difference with time for measured DO, pH, alkalinity and total phosphate values for the test period using existing equipment and sampling techniques.

The following stations were accepted as the sampling grid meeting the water quality and biological sampling requirements of The Hydro-Electric Power Commission of Ontario, the Ontario Department of Lands and Forests, The Steel Company of Canada Limited and the Ontario Water Resources Commission (see map):

Stations

994	5016
501	810
5008	648
112	518

Sampling of the stations should occur at the same time of day within a few hours.

REQUIRED DENSITY OF WATER QUALITY SAMPLING STATIONS
AT NANTICOKE, LAKE ERIE

INTRODUCTION

With the construction of a thermal generating station and the proposed industrial development in the Nanticoke area on Lake Erie, it is necessary to determine the existing water quality in the area before and after development occurs to assess the changes, if any, to the water environment. To do this economically, with existing survey techniques, it was necessary to determine the required sampling station density, such that each station would provide unique information and not duplicate results from other stations.

The Water Quality Surveys Branch carried out two detailed studies on the 1st of August and 10th of September, 1968, extending over 24 and 10 hour periods respectively, to determine the station density requirements in the area. The studies also provided information on the diurnal effects on water quality parameters. Once the density of stations required was determined, surveying efforts in the area will then be restricted to these stations. Both biological and chemical samples will be collected at time intervals over the year to provide an accurate assessment of the existing environment.

PURPOSE

1. To test the hypothesis:
 - (a) There is no significant difference in water quality (dissolved oxygen (DO), pH, alkalinity, and total phosphate) for stations spaced approximately two miles apart in the Nanticoke area with existing equipment and sampling techniques.
 - (b) There is no significant time difference (10 hour variation) in water quality (DO, pH, alkalinity and total phosphates) at the chosen stations with existing equipment and techniques.
2. To confirm the results of Nanticoke study, August 1-2, 1968.
3. To gather information on other water quality parameters for The Steel Company of Canada Limited.

PROCEDURE

The following stations were sampled over a 10 hour period at 2 hour intervals:

Stations

5004
994
501

These stations are approximately two miles apart (see map). Multiple samples were taken for DO, pH, alkalinity and total phosphate at the mid-depth. Each of the samples was analyzed independantly. For the results, see Appendix 1.

RESULTS

The results of the analysis of variance are tabulated in Appendix 2 and summarized as follows:

1. There is a significant difference between stations 5004, 994 and 501 in measured alkalinity and total phosphate values while there is no significant difference for measured DO and pH values for the test period.
2. There is a significant difference with time for measured values of DO, pH, alkalinity and total phosphates for the test period.

A problem exists in the application of a two-way analysis of variance if the interaction terms are significant as they are for DO, pH and total phosphate. However, the results are valid in that overall treatment effects do exist as determined by the two-way analysis, but to specify exactly how the treatment differ one must look within levels of the other factor (Hays, 1963) or do analysis as several one-ways (Bowker, 1959).

As we are concerned only with the overall differences between stations to determine a reasonable sampling grid, the two-way analysis results are valid.

When the results of this study were compared with the results of the study on August 1 (see Appendix 3) which was for stations spaced approximately one mile apart the following is observed:

1. Differences

Parameter	Source of Variation	August 1 Station Spacing 1 mile	September 10 Station Spacing 2 miles
pH	Between stations	Significant	Not Significant
Alkalinity	Between stations	Not Significant	Significant
Total Phos.	Between stations	Not Significant	Significant
Conductivity	Between stations	Significant	-

2. Similarities

Parameter	Source of Variation	August 1 Station Spacing 1 mile	September 10 Station Spacing 2 miles
DO, pH, Alkalinity & Total Phos.	Time	Significant	Significant
DO	Stations	Not Significant	Not Significant
Conductivity	Time	Not Significant	-

Based upon the preceding comparisons the two mile station spacing is required to detect significant differences in water quality and it is extremely important that the stations be sampled at the same time of day, within a few hours, otherwise false differences will occur between the stations.

The conflicting results obtained for pH between the two studies is puzzling. There appears to be a local ionic effect detected in the August 1 study area which did not appear in the September 10 study area. It is not economical to select stations spaced one mile apart on the basis of pH differences only. However, by using the guidelines of two mile station spacing and judiciously selecting the stations such that one of the proposed study stations lies between station 111 and 807 and another proposed station is close to station 459, it is felt that this pH difference will still be detected.

CONCLUSIONS

Sampling stations in the Nanticoke area should be spaced two miles apart and sampling at the stations should occur at the same time of day within a few hours.

As a result of discussions with The Hydro-Electric Power Commission of Ontario, the Ontario Department of Lands and Forests, The Steel Company of Canada Limited and the Ontario Water Resources Commission

a sampling grid consisting of (see map):

Stations

994	5016
501	810
5008	648
112	518

was adopted as meeting the water quality and biology survey requirements in the area.

REFERENCES

Bowker, A. and Lieberman, G., 1959.
Engineering Statistics. Prentice Hall,
p. 286 - 342.

Hays, W., 1963.
Statistics for Psychologists,
Holt, Rinehard, Winston
p. 391.

APPENDIX I
MULTIPLE SAMPLING RESULTS

NANTICOKE

SEPTEMBER 10, 1968

DISSOLVED OXYGEN - PERCENT SATURATION

Station	TIME				
	1000 Hrs.	1200 Hrs.	1500 Hrs.	1700 Hrs.	1900 Hrs.
5004	87	96	100	101	97
	90	98	101	101	100
	96	95	99	100	100
994	94	96	98	102	100
	95	91	98	99	100
	97	95	95	100	99
501	98	97	97	99	98
	95	98	99	98	99
	97	96	97	98	99

p H (Su)

Station	TIME				
	1000 Hrs.	1200 Hrs.	1500 Hrs.	1700 Hrs.	1900 Hrs.
5004	8.1	8.5	8.2	8.6	8.6
	8.3	8.5	8.3	8.6	8.6
	8.3	8.5	8.5	8.7	8.7
994	8.2	8.5	8.5	8.2	8.6
	8.3	8.5	8.5	8.4	8.6
	8.5	8.6	8.5	8.4	8.6
501	8.4	7.8	8.4	8.6	8.4
	8.5	8.3	8.5	8.6	8.4
	8.2	8.4	8.6	8.5	8.5

MULTIPLE SAMPLING RESULTS

NANTICOKE

SEPTEMBER 10, 1968

ALKALINITY CaCO_3 ppm

TIME

Station	1000 Hrs.	1200 Hrs.	1500 Hrs.	1700 Hrs.	1900 Hrs.
5004	100	104	102	104	101
	103	99	100	99	98
	104	101	104	100	98
994	104	99	100	98	101
	101	103	95	99	95
	100	102	100	98	100
501	100	97	100	98	94
	101	100	96	98	97
	100	103	101	99	97

TOTAL PHOSPHATES

PO_4 ppm

TIME

Station	1000 Hrs.	1200 Hrs.	1500 Hrs.	1700 Hrs.	1900 Hrs.
5004	0.10	0.11	0.12	0.05	0.04
	0.10	0.09	0.10	0.04	0.05
	0.12	0.09	0.07	0.04	0.04
994	0.09	0.08	0.06	0.05	0.04
	0.10	0.09	0.06	0.04	0.04
	0.10	0.09	0.05	0.05	0.04
501	0.10	0.08	0.06	0.05	0.05
	0.09	0.10	0.05	0.04	0.04
	0.09	0.10	0.05	0.04	0.03

OTHER PARAMETERS

Station 5004

1200 Hrs.

Suspended Solids 16 ppm

Dissolved Solids 196 ppm

Total Solids 212 ppm

Iron 0.25 ppm

Tin <0.1 ppm

Zinc 0.0

Ether Soluble 1.0 ppm

APPENDIX 2

TABLE OF RESULTS

ANALYSIS OF VARIANCE

NANTICOKE

SEPTEMBER 10, 1968

Stations Compared - 5004, 994, 501
Time Period - 1000 hrs. to 1900 hrs in 2 hr. intervals

Parameter	Source of Variation	Test
1. Dissolved Oxygen	Between stations	Not Significant 0.10
Percent	Time	Significant 0.001
Saturation	Interaction	Significant 0.005
2. pH	Between stations	Not Significant 0.10
Su	Time	Significant 0.005
	Interaction	Significant 0.005
3. Alkalinity	Between stations	Significant 0.025
ppm CaCO_3	Time	Significant 0.025
	Interaction	Not Significant 0.10
4. Total Phosphate	Between stations	Significant 0.005
ppm PO_4	Time	Significant 0.001
	Interaction	Significant 0.01

APPENDIX 3

TABLE OF RESULTS

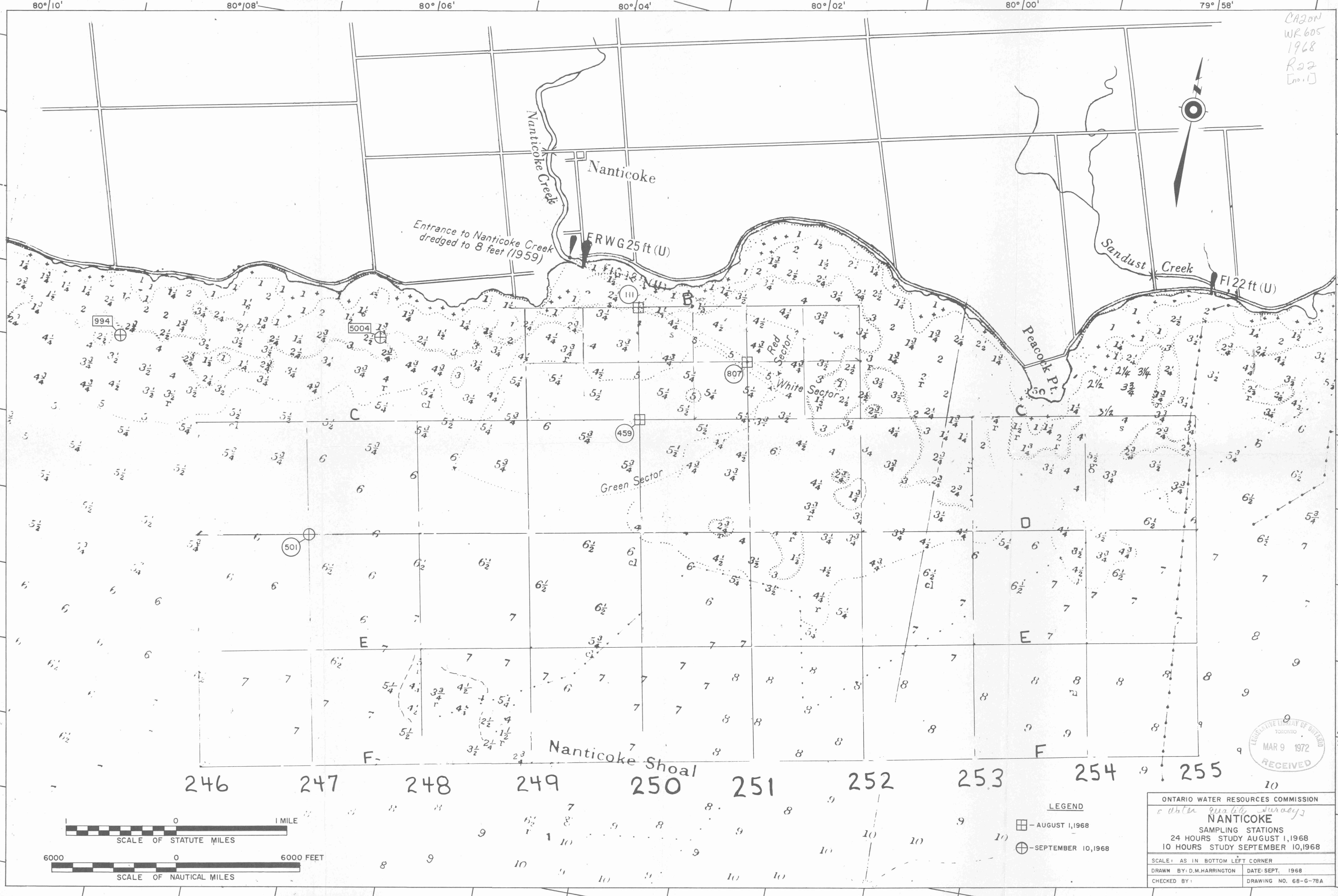
ANALYSIS OF VARIANCE

NANTICOKE

AUGUST 1, 1968

Stations Compared - 111, 459, 807
Time Period - 24 Hrs. 6 runs at 4 hour intervals

Parameter	Source of Variation	Test
1. Dissolved Oxygen	Between stations	Not Significant 0.10
Percent	Time	Significant 0.001
Saturation	Interaction	Not Significant 0.10
2. pH	Between stations	Significant 0.001
Su	Time	Significant 0.001
	Interaction	Not Significant 0.10
3. Alkalinity	Between stations	Not Significant 0.10
ppm CaCO ₃	Time	Significant 0.025
	Interaction	Not Significant 0.10
4. Total Phosphate	Between stations	Not Significant 0.10
	Time	Significant 0.001
5. Conductivity	Between stations	Significant 0.025
umhos/cm	Time	Not Significant 0.10



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ONTARIO WATER RESOURCES COMMISSION
NANTICOKE
SAMPLING STATIONS
24 HOURS STUDY AUGUST 1, 1968
10 HOURS STUDY SEPTEMBER 10, 1968
SCALE: AS IN BOTTOM LEFT CORNER
DRAWN BY: D.M. HARRINGTON DATE: SEPT. 1968
CHECKED BY: DRAWING NO. 68-G-78A



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